

BRIEF REPORT

Traumatic Brain Injury and Suicidal Ideation Among U.S. Operation Enduring Freedom and Operation Iraqi Freedom Veterans

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Traumatic brain injury (TBI) is associated with suicidal behavior among veterans, and gender differences in the strength of associations may exist. Almost all research has been limited to Veterans Health Administration (VHA) patients, and it is unclear if findings generalize to veterans who do not use VHA services. We examined gender- and VHA-user-specific associations between TBI related to deployment and postdeployment suicidal ideation in a U.S. national sample of 1,041 female and 880 male Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) veterans. Path analysis was used to estimate TBI and suicidal ideation association, and examine PTSD and depression symptomatology in these associations. TBI was associated with suicidal ideation among male VHA users, $OR = 3.64$, 95% CI [2.21, 6.01]; and male and female nonusers, $OR = 2.24$, 95% CI [1.14, 4.44] and $OR = 2.65$, 95% CI [1.26, 5.58], respectively, in unadjusted analyses. This association was explained by depression symptoms among male and female nonusers. Among male VHA users an association between TBI and suicidal ideation remained when accounting for depression symptoms, $OR = 2.50$, 95% CI [1.33, 4.71]. Our findings offered evidence of an association between TBI and suicidal ideation among male OEF/OIF VHA users.

Studies have indicated that traumatic brain injury (TBI) may increase risk for suicidal ideation and behaviors among veterans (e.g., Brenner, Betthausen, et al., 2011; Brenner, Ignacio, & Blow, 2011; Wisco et al., 2014). Prior research, however, has been unclear about the extent to which this association can be explained by symptoms of posttraumatic stress disorder (PTSD) and other psychiatric conditions (Brenner, Betthausen, et al., 2011; Brenner, Ignacio, et al., 2011). Wisco and colleagues (2014) found an association between TBI and suicidal ideation among male, but not female, Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) Veterans Health Administration (VHA) patients (adjusting for PTSD and

depression symptoms), indicating that gender adds a layer of complexity to these important associations.

Notably, all prior research on this topic has been conducted with veterans using VHA health care services (Brenner, Betthausen, et al., 2011; Brenner, Ignacio, et al., 2011; Wisco et al., 2014). As a result, it is unclear if these previous findings generalize to veterans who do not use VHA services. According to recent estimates, only 59% of OEF/OIF veterans use VHA services (U.S. Veterans Health Administration Epidemiology Program, 2014). and veterans using VHA care may differ from those who do not in ways that might influence the association between TBI and suicidal behaviors (e.g., more severe and chronic PTSD and other psychiatric symptoms; Miller & Intrator, 2012). Thus, this study examined the gender and VHA-user specific associations between deployment-related TBI and post-deployment suicidal ideation among OEF/OIF veterans, and examined the roles of PTSD and depression symptomatology in these associations.

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Method

Participants and Procedure

A description of the parent study has been published elsewhere (Street, Gradus, Vogt, Giasson, & Resick, 2013). In brief,

Table 1
 Characteristics of Sample by Gender and Use of VHA Health Care

Variable	Women (n = 1,041)					Men (n = 880)				
	User (n = 505)		Nonuser (n = 536)		V or d	User (n = 418)		Nonuser (n = 462)		V or d
	n or M	% or SD	n or M	% or SD		n or M	% or SD	n or M	% or SD	
Race					0.10*					0.08*
White	318	65.8	387	74.9		315	79.5	381	85.2	
Non-White	165	34.2	130	25.1		81	20.5	66	14.8	
Education					0.14***					0.17***
High school level	40	8.0	30	5.6		96	23.1	86	18.8	
Some college	256	50.7	228	42.7		217	52.2	196	42.8	
≥ College grad	209	41.4	276	51.7		103	24.8	176	38.4	
Deployed	374	77.3	328	62.6	0.16***	352	88.2	327	73.3	0.19***
Enlisted rank	429	87.7	383	73.1	−0.18***	360	90.6	360	79.8	−0.15***
Active duty	274	54.7	288	53.9	−0.01	220	53.0	217	47.7	−0.06
Probable TBI	75	16.2	36	7.2	0.14***	120	33.1	57	13.8	0.23***
Suicidal ideation	127	27.1	97	18.7	0.10**	110	28.0	67	14.9	0.16***
Age (years)	34.53	8.92	34.70	8.92	0.02	35.76	9.89	38.28	9.83	0.26***
PTSD symptoms	39.98	20.73	29.74	15.06	0.57***	42.96	19.91	30.37	14.56	0.72***
DEP symptoms	10.87	7.69	7.65	6.42	0.46***	10.10	7.21	6.33	5.63	0.58***

Note. VHA = Veterans Health Affairs; TBI = traumatic brain injury; PTSD = posttraumatic stress disorder; DEP = depression. Chi-square test used to test differences between VA users and nonusers on dichotomous variables; independent samples *t* test used for continuous variables.

p* < .05. *p* < .01. ****p* < .001.

6,000 potential participants were randomly sampled (within gender) from the VHA Environmental Epidemiology Service's roster of veterans who deployed as part of OEF and/or OIF and were separated from military service, with women over-sampled. Total respondents were 1,209 female and 1,139 male veterans (39.1% crude response rate; 48.6% response rate after accounting for ineligible responders). We excluded 21 participants who endorsed forms of suicidal behavior that were more severe than ideation since their most recent deployment (e.g., suicide attempts). The final sample included 1,041 women and 880 men who had answered a survey question regarding use of VHA services. Table 1 displays the characteristics of the sample. Participants were in their thirties on average, predominantly Caucasian, most reported having some college education, and most had deployed to either Iraq or Afghanistan. Among both women and men, small differences between VHA users and nonusers were found for race (Cramér's *V* = 0.10 and 0.08), education (Cramér's *V* = 0.14 and 0.17), deployment to Iraq and/or Afghanistan only (Cramér's *V* = 0.16 and 0.19), enlisted rank (Cramér's *V* = −0.18 and −0.15), probable TBI (Cramér's *V* = 0.14 and 0.23), and suicidal ideation (Cramér's *V* = 0.10 and 0.16). Differences between VHA users and nonusers were also found for age among men only (Cohen's *d* = 0.26), and PTSD symptoms (Cohen's *d* = 0.57 and 0.72) and depression (Cohen's *d* = 0.46 and 0.58) among both women and men.

Data collection had occurred between September 2009 and November 2010. Veterans were contacted using Dillman's tailored design method (Dillman, 2007). An introductory letter

was sent to potential participants, followed approximately 1 week later by a survey packet including an informed consent fact sheet (which indicated that returning the survey was considered consent to participate), survey, and \$5 cash incentive. Reminder postcards were sent to all potential participants the following week and additional packets were sent to nonresponders approximately 2 weeks later. The remaining individuals who had not responded were sent a final survey packet through priority mail 2 weeks later. This study was approved by the VA Boston Healthcare System Institutional Review Board.

Measures

The PTSD Checklist-Military Version (PCL-M; Weathers, Litz, Herman, Huska, & Keane, 1993) was used to assess the 17 symptoms of PTSD according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; DSM-IV-TR; American Psychiatric Association, 2000) with questions anchored to "stressful deployment experiences." Participants rated how bothered they were by each symptom within the past month using 1 = *not at all* through 5 = *extremely bothered*. Cronbach's α was .97.

The Traumatic Brain Injury Quick Screen for Veteran Populations measure assessed probable deployment-related TBI (Arlinghaus & Hickey, 2005). Consistent with the American Congress of Rehabilitation Medicine and VA/Department of Defense (DoD) clinical practice guidelines (U.S. Department of Veterans Affairs and the U.S. Department of Defense, 2009),

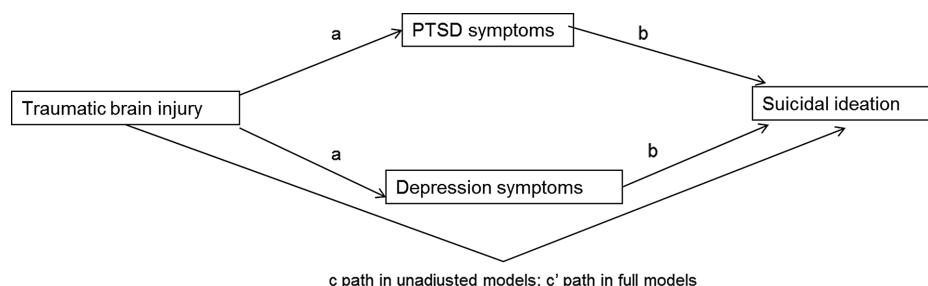


Figure 1. Diagram of path analysis showing the hypothesized associations between traumatic brain injury (TBI), posttraumatic stress disorder (PTSD), and depression symptoms and suicidal ideation among Operation Enduring Freedom/Operation Iraqi Freedom veterans. a paths = associations between TBI and mental health symptoms; b paths = associations between mental health symptoms and suicidal ideation; c path = crude association between TBI and suicidal ideation; c' path = association between TBI and suicidal ideation conditioned on mental health symptoms; ab paths = estimate of the joint effect of the TBI and mental health symptoms on the suicidal ideation.

participants were coded as having probable TBI if they reported at least one deployment-related event in which they experienced an alteration or loss of consciousness as a result of a blast or nonblast-related head injury.

The Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) was used to measure past week depression symptoms with response options ranging from 1 = *None of the time or less than one day* to 4 = *5–7 days* to quantify symptom frequency. Cronbach's α was .97. The correlation between the PCL-M and the CES-D scores in this sample was .76.

The Suicidal Behaviors Questionnaire-Short Form (SBQ-SF; Linehan, 1996), a 4-item measure, was used to assess suicidal behaviors and thoughts occurring since the most recent deployment. One question was used for the current analyses (i.e., "Since your most recent deployment to OEF/OIF, have you thought about or attempted to kill yourself?"). Multiple responses to this question were dichotomized into no ideation (participant response of no) and yes ideation (participant responses of "It was just a passing thought"; "I briefly considered it, but not seriously"; "I thought about it and was somewhat serious").

Data Analysis

Regression-based path analysis was used to estimate the association between TBI and suicidal ideation while examining the role of PTSD and depression symptomatology simultaneously (see Figure 1). Pathways were tested using the PROCESS macro for SPSS v21 (Hayes, 2013). To test paths through covariates, 95% bias-corrected confidence intervals (CIs) were calculated based on 1,000 bootstrap samples, with a CI not containing zero indicating a significant effect. The sample was stratified on gender and VHA user status for all analyses.

Results

Results of the path analyses are displayed in Table 2. Among female veterans who were non-VHA users, TBI was associated with postdeployment suicidal ideation in adjusted analyses, c

path: odds ratio [OR] = 2.65, 95% CI [1.26, 5.58]. Analysis of this association with PTSD and depression symptoms included in the model revealed that depression (a_2b_2 path), but not PTSD (a_1b_1 path), symptoms accounted for the TBI and suicidal ideation association, c' path: OR = 1.28, 95% CI [0.53, 3.09].

Among male veterans, TBI was associated with suicidal ideation (c path) for VHA users, OR = 3.64, 95% CI [2.21, 6.01], and non-VHA users, OR = 2.24, 95% CI [1.14, 4.44]. For non-VHA users, this association was accounted for by PTSD and depression symptomatology, c' path: OR = 0.80, 95% CI [0.33, 1.92], with a significant path through depression (a_2b_2 path), but not PTSD (a_1b_1 path), symptoms. Among male VHA users, the association between TBI and suicidal ideation was partly explained by PTSD and depression symptomatology, with a significant path through depression (a_2b_2 path), but not PTSD (a_1b_1 path), symptoms. An association between TBI and suicidal ideation, however, was still found among male VHA users, beyond what could be explained by depression symptoms, c' path: OR = 2.50, 95% CI [1.33, 4.71].

Discussion

This study found that deployment-related TBI was associated with postdeployment suicidal ideation among male VHA users and male and female non-VHA users in crude analyses. Among non-VHA users, this association occurred primarily through depression symptoms. This was inconsistent with a report that PTSD accounted for the TBI and suicide attempt association in VHA patients (Brenner, Bethausen, et al., 2011). Depression symptoms, however, were not examined in that study. Given the frequent co-occurrence of PTSD and depression among veterans with TBI (Iverson et al., 2011), this pattern of findings may have differed if depression symptoms had been included. Our results were indicative of potential mediation of TBI and suicidal ideation by depression symptoms. Future research should explore this possibility using longitudinal data.

We found that TBI was independently associated with suicidal ideation among male VHA users only, above what can

Table 2

Path Analysis Coefficients of Symptoms of PTSD and Depression on the Association of TBI and Suicidal Ideation by Gender and VHA User Status

Path	Women (n = 1,041)						Men (n = 880)					
	User (n = 505)			Nonuser (n = 536)			User (n = 418)			Nonuser (n = 462)		
	B	SE	95% CI	B	SE	95% CI	B	SE	95% CI	B	SE	95% CI
TBI to PTSD (a ₁)	23.60***	2.42		16.34***	2.50		18.55***	2.05		15.96***	1.85	
TBI to DEP(a ₂)	6.20***	0.94		4.40***	1.09		3.75***	0.79		4.17***	0.78	
PTSD to SI (b ₁)	0.01	0.01		0.02	0.01		0.00	0.01		0.03*	0.02	
DEP to SI (b ₂)	0.14***	0.03		0.14***	0.03		0.17***	0.03		0.12**	0.04	
TBI to SI (c) ^a	0.38	0.30		0.97*	0.38		1.29***	0.26		0.81*	0.35	
TBI to SI (c') ^b	-0.68	0.38		0.24	0.45		0.92*	0.32		-0.23	0.45	
TBI to SI through PTSD (a ₁ b ₁)	0.17	0.25	[-0.31, 0.67]	0.24	0.19	[-0.05, 0.72]	0.06	0.22	[-0.38, 0.51]	0.48	0.28	[-0.05, 1.06]
TBI to SI through DEP (a ₂ b ₂)	0.89*	0.21	[0.50, 1.31]	0.62*	0.21	[0.27, 1.11]	0.63*	0.20	[0.29, 1.06]	0.48*	0.21	[0.16, 1.04]

Note. 95% confidence interval (CI) calculated only for estimates of indirect paths; CI that does not include 0 is indicative of a significant indirect; PTSD = posttraumatic stress disorder; TBI = traumatic brain injury; VHA = Veterans Health Administration; DEP = depression; SI = suicide ideation; B = unstandardized β ; CI = confidence interval.

^aUnadjusted model. ^bAdjusted model.

* $p < .05$. ** $p < .01$. *** $p < .001$.

be explained by depression symptoms. This expands upon the work of Wisco and colleagues (2014) by examining associations among VHA users and non-VHA users, and demonstrating that this association is unique to male OEF/OIF veterans who use VHA services. Although our results cannot explain this differential gender and VHA user effect, one possibility is that male VHA users may have had different etiologies of TBI (e.g., more blast-related TBI), or a greater frequency or severity of TBIs, relative to male non-VHA users or female veterans. Accordingly, our sample characteristics indicate that male VHA users also had the highest proportion of TBI in our sample. It is possible that this group experienced a greater frequency of TBIs and/or a greater range of TBI severity. Additional research is needed to examine whether TBI frequency and severity play a role in this unique association between TBI and suicidal ideation among male VHA users. Finally, it is possible that there were uncontrolled variables that may account for the observed association between TBI and suicidal ideation (SI) among male VHA users in the current study (e.g., perceived burdensomeness, chronic pain, substance use). Future research will need to examine the robustness of this association while adjusting for these and other potentially important covariates.

Although we assessed deployment-related TBI and postdeployment depression symptoms, PTSD symptoms, and suicidal

ideation, all data were obtained cross sectionally via self-report. Therefore, it is impossible to make causal inferences. Our self-report TBI measure was consistent with screening instruments used in other military studies (Hoge et al., 2008; Polusny et al., 2011), but did not include posttraumatic amnesia, a VA/DoD (2009) criterion for determining TBI. As a result, some TBI cases may have been misclassified. Further, we did not assess TBI etiology, frequency, severity, or length of time since TBI, which may have been important in risk for suicidal ideation. Additional limitations include the PCL-M instructions to respond with regard to deployment events only (potentially excluding symptom reports based on events occurring before and after deployment) and the use of one item to assess suicidal ideation. Finally, our response rate was just below 50%. Although this is comparable with other large OEF/OIF veteran studies (Smith, Smith, Gray, & Ryan, 2007), it is possible that the associations presented may differ between survey responders and nonresponders.

Our results corroborated recent research pointing to a unique association between TBI and suicidal ideation among male OEF/OIF veterans who use VHA care (Wisco et al., 2014), and expand upon this work by providing evidence of this specific association in a sample that included VHA nonusers as well. Screening for suicide risk among this population should

include a comprehensive assessment of TBI experiences paired with appropriate referrals, even in the absence of mental health symptoms.

References

- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Arlington, VA: Author.
- Arlinghaus, K. A., & Hickey, J. A. (2005). *TBI quick screen for a veteran population*. Unpublished measure.
- Brenner, L. A., Betthausen, L. M., Homaifar, B. Y., Villarreal, E., Harwood, J. E. F., Staves, P. J., & Huggins, J. A. (2011). Posttraumatic stress disorder, traumatic brain injury, and suicide attempt history among veterans receiving mental health services. *Suicide & Life-Threatening Behavior*, 41, 416–423. doi:10.1111/j.1943-278X.2011.00041.x
- Brenner, L. A., Ignacio, R. V., & Blow, F. C. (2011). Suicide and traumatic brain injury among individuals seeking Veterans Health Administration services. *Journal of Head Trauma Rehabilitation*, 26, 257–264. doi:10.1097/HTR.0b013e31821fdb6e
- Dillman, D. A. (2007). *Mail and Internet surveys: The tailored design method*. Hoboken, NJ: Wiley.
- Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analyses: A regression-based approach*. New York, NY: Guilford Press.
- Hoge, C. W., McGurk, D., Thomas, J. L., Cox, A. L., Engel, C. C., & Castro, C. A. (2008). Mild traumatic brain injury in US soldiers returning from Iraq. *New England Journal of Medicine*, 358, 453–463. doi:10.1056/NEJMoa072972
- Iverson, K. M., Hendricks, A. M., Krengel, M., Meterko, M., Stolzmann, K. L., Baker, E., . . . Lew, H. L. (2011). Psychiatric diagnoses and neurobehavior symptom severity among OEF/OIF VA patients with deployment-related traumatic brain injury: A gender comparison. *Women's Health Issues*, 21, S210–S217. doi:10.1016/j.whi.2011.04.019
- Linehan, M. M. (1996). Suicidal Behaviors Questionnaire (SBQ). Unpublished inventory, University of Washington, Seattle.
- Miller, E. A., & Intrator, O. (2012). Veterans use of non-VHA services: Implications for policy and planning. *Social Work in Public Health*, 27, 379–391. doi:10.1080/19371910903176197
- Polusny, M. A., Kehle, S. M., Nelson, N. W., Erbes, C. R., Arbisi, P. A., & Thuras, P. (2011). Longitudinal effects of mild traumatic brain injury and posttraumatic stress disorders comorbidity on postdeployment outcomes in national guard soldiers deployed to Iraq. *Archives of General Psychiatry*, 68, 79–89. doi:10.1001/archgenpsychiatry.2010.172
- Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, 1, 358–401. doi:10.1177/014662167700100306
- Smith, B., Smith, T. C., Gray, G. C., & Ryan, M. A. K. (2007). When epidemiology meets the Internet: Web-based surveys in the Millennium Cohort Study. *American Journal of Epidemiology*, 116, 1345–1354. doi:10.1093/aje/kwm212
- Street, A. E., Gradus, J. L., Vogt, D., Giasson, H. L., & Resick, P. A. (2013). Gender differences among veterans deployed in support of the wars in Afghanistan and Iraq. *Journal of General Internal Medicine*, 28, 556–562. doi:10.1007/s11606-013-2333-4
- U.S. Department of Veterans Affairs and the U.S. Department of Defense. (2009). *VA/DoD clinical practice guideline for management of concussion/mild traumatic brain injury*. Washington, DC: Author.
- U.S. Veterans Health Administration Epidemiology Program. (2014). Analysis of VA health care utilization among Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF) and Operation New Dawn (OND) veterans: Cumulative from 1st qtr FY 2002 through 1st qtr FY 2014. Retrieved from <http://www.publichealth.va.gov/docs/epidemiology/healthcare-utilization-report-fy2014-qtr1.pdf>
- Weathers, F. W., Litz, B. T., Herman, D. S., Huska, J. A., & Keane, T. M. (1993, October). The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility. Paper presented at the 9th annual meeting of the International Society for Traumatic Stress Studies, San Antonio, TX.
- Wisco, B. E., Marx, B. P., Holowka, D. W., Vasterling, J. J., Han, S., Chen, M., . . . Keane, T. M. (2014). Traumatic brain injury, PTSD, and current suicidal ideation among Iraq and Afghanistan veterans. *Journal of Traumatic Stress*, 27, 1–5. doi:10.1002/jts.21900